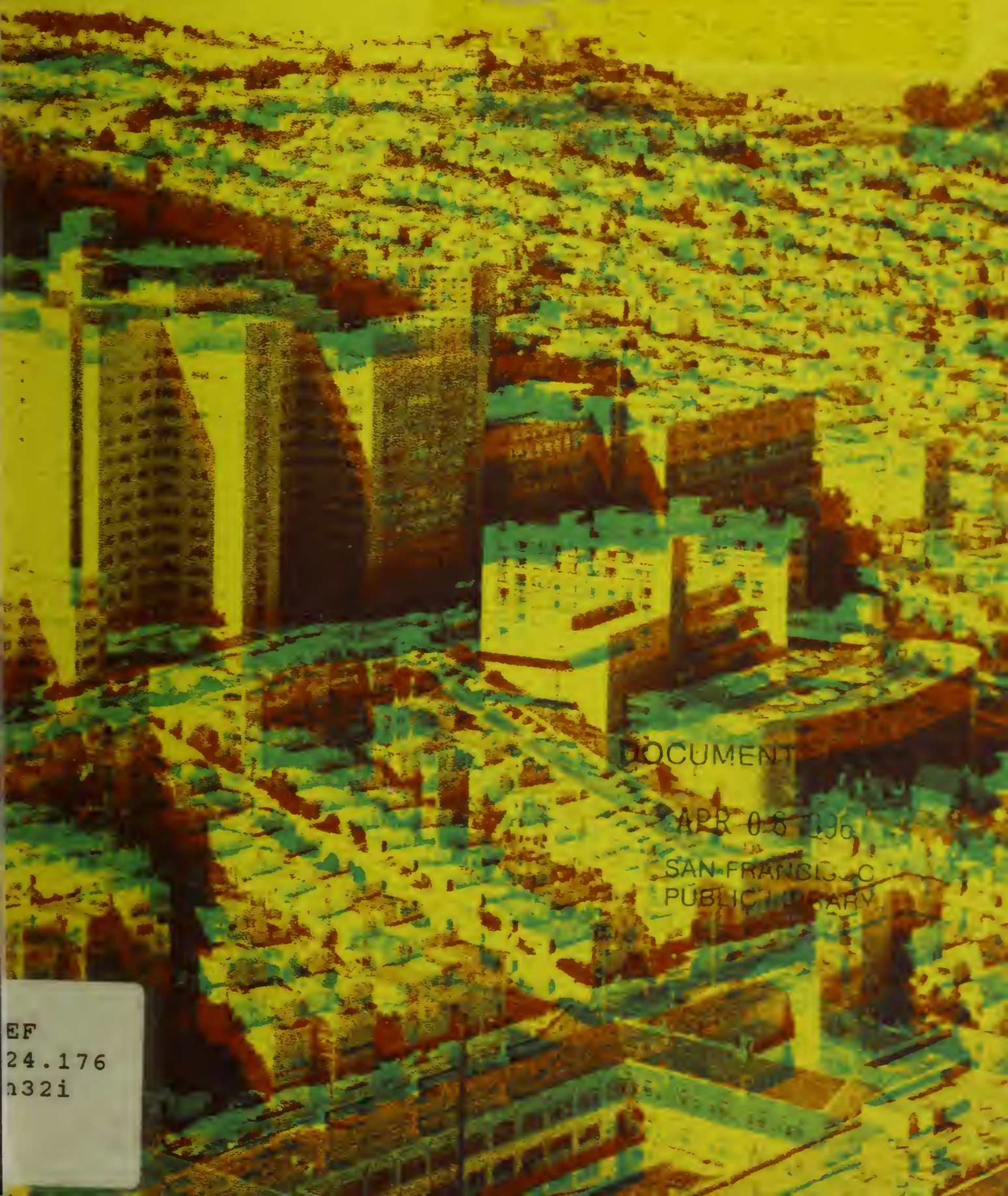
# IN THE INTEREST OF EARTHQUAKE SAFETY

INSTITUTE OF GOVERNMENTAL STUDIES
University of California, Berkeley
1971



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EUGENE C. LEE, *Director*

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IN THE INTEREST OF EARTHQUAKE SAFETY

# IN THE INTEREST OF EARTHQUAKE SAFETY

Findings and Conclusions by Members of the
Task Force on Earthquake Hazard Reduction
Office of Science and Technology
Executive Office of the President

INSTITUTE OF GOVERNMENTAL STUDIES
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# FOREWORD

This report summarizes background information, findings and conclusions developed by the Task Force on Earthquake Hazard Reduction. Copies of the Task Force report—*Earthquake Hazard Reduction* (August, 1970)—are available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402, at a price of 55 cents per copy.

The list of contributors reads the same as the membership of the Task Force and its advisors. But it should be clearly understood that the material in the following pages represents only the collective views of the contributors. The report should not be construed as official policy of the Office of Science and Technology.

Because of its continuing interest in unresolved policy questions involving seismic safety, the Institute of Governmental Studies has issued this document as a public service. It is intended to complement the Task Force report by interpreting the group's findings for general readers who do not possess technical knowledge of earthquake sciences.

On behalf of the contributors I express gratitude for the many helpful suggestions and comments by Carl Savit, Office of Science and Technology, during the Task Force deliberations. Finally, I would like to acknowledge Stanley Scott's leadership in drafting this report, as well as Harriet Nathan's editorial refinements, and other Institute staff members' contributions in helping prepare it for publication.

Karl V. Steinbrugge
*Chairman*

## CONTRIBUTORS


KARL V. STEINBRUGGE, *Chairman*
Professor of Structural Design
University of California, Berkeley

CLARENCE R. ALLEN
Professor of Geology and Geophysics
Seismological Laboratory
California Institute of Technology
Pasadena, California

HENRY J. DEGENKOLB
Consulting Structural Engineer
H. J. Degenkolb and Associates
San Francisco, California

RICHARD H. JAHNS
Dean, School of Earth Sciences
Stanford University
Stanford, California

MORTIMER KAPLAN
Consulting Actuary
Springfield, Massachusetts

NATHAN M. NEWMARK
Head, Department of Civil Engineering
University of Illinois
Urbana, Illinois

E. JACK SCHOOP
Chief Planner, San Francisco Bay Conservation and Development Commission
San Francisco, California

STANLEY SCOTT
Assistant Director
Institute of Governmental Studies
University of California
Berkeley, California

ROBERT F. SHEA
Vice President
The American National Red Cross
Washington, D. C.

JAMES G. STEARNS
Director, Department of Conservation
Resources Agency
State of California
Sacramento, California

JAMES T. WILSON
Director, Institute of Science and Technology
University of Michigan
Ann Arbor, Michigan

A NATION'S GOAL . . .

*As we move into a new decade, one of the nation's major goals is to restore a ravaged environment. But we must also be ready to respond effectively when nature gets out of hand and victimizes our citizens.*

Richard M. Nixon
(Message from the President of the United States Relative to Disaster Assistance, April 22, 1970)

A GEOLOGIST'S WARNING . . .

*During the next 25 years we can expect, in various parts of the United States, at least one great earthquake, several major earthquakes, and numerous lesser damaging shocks.*

*A single earthquake of Richter magnitude eight or more, were it to occur in a metropolitan area under unfavorable circumstances of weather, time of day, and human response, could cause damage of billions to tens of billions of dollars, and the loss of hundreds to tens of thousands of lives.*

Richard H. Jahns
(Member of the Task Force on Earthquake Hazard Reduction, May 4, 1970)

# I.

## Introduction: Earthquakes and Other Disasters

The hurricane and tidal wave in East Pakistan, the Peruvian earthquake of 1970, and the Gulf Coast havoc of Hurricane Camille are recent examples of natural catastrophes. Farther back in time, the Alaskan earthquake of 1964, the Texas City explosions of 1947, and the San Francisco earthquake of 1906 are three more examples from a long list of peacetime tragedies.

The magnitude of such major disasters cannot help but inspire awe and terror in those who are present when they happen. Yet incredulity and disbelief are also typical responses to disasters that are relatively remote in time or distance. The human tendency to

minimize or ignore possible calamities that we do not like to think about undoubtedly helps preserve a temporary peace of mind between crises. But it also discourages disaster preparedness.

Anything that deters prudent precautions will cause future misfortunes to exact a needless toll of life and property. Conversely, adequate safety measures can yield high rewards for the hard work and careful planning that are essential to counter apathy, unawareness and inaction. Without such efforts, lack of preparation is likely to prove devastating in a major disaster.

## 1. The Task Force Assignment

The Task Force's principal assignment was to inventory what we now know about the earthquake hazard and its reduction, to assess our progress in applying this knowledge, to suggest guidelines for action programs, and to recommend promising new research efforts.

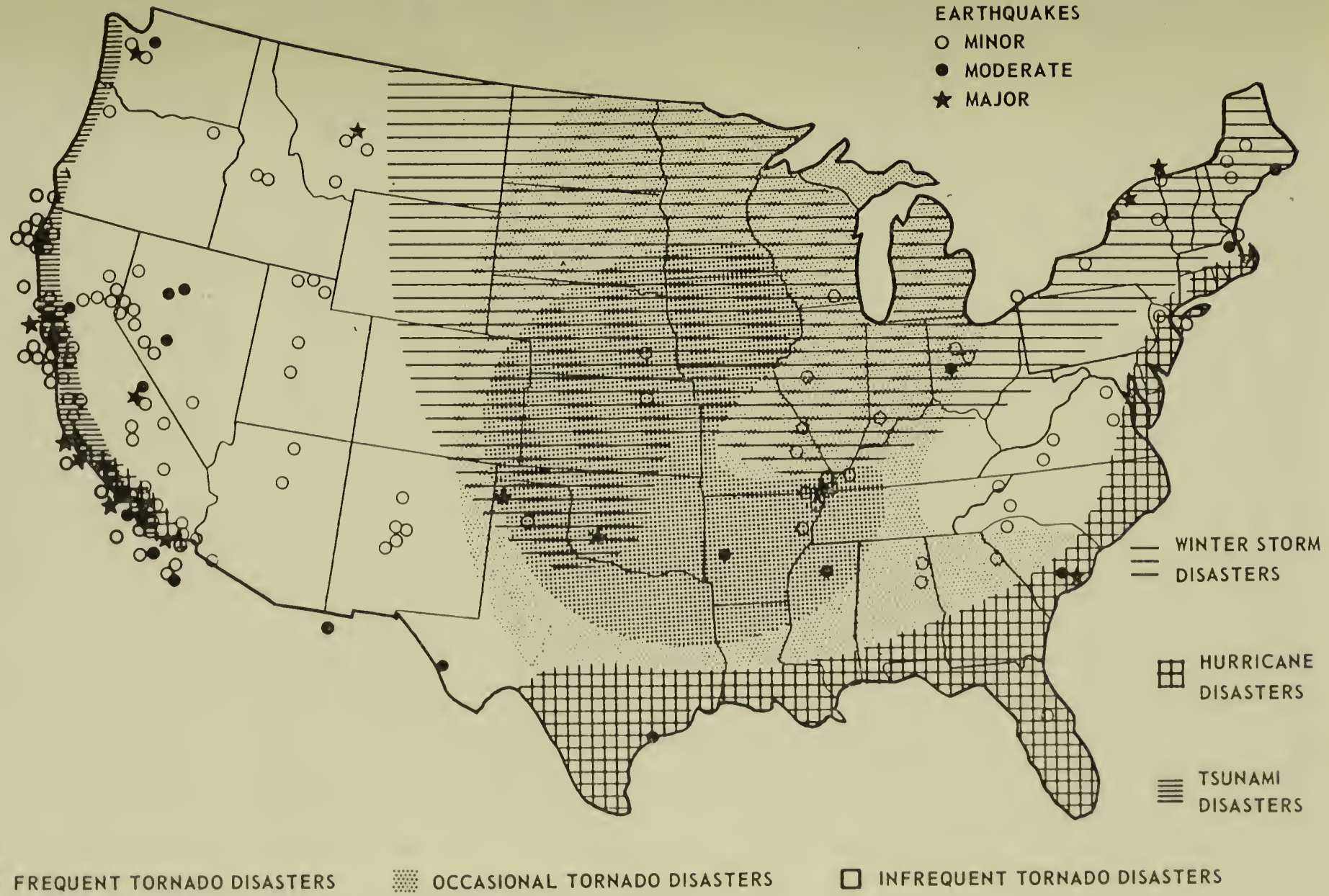
While we already know a good deal about earthquakes and methods of reducing hazards, we also need to know much more. Crucial information is missing in many areas, and existing knowledge is not being utilized effectively. We lack appropriate and responsive public policies, based on the best information available, and we lack dependable machinery to implement such policies.

Thus we can make present knowledge yield major new benefits by devising improved hazard-reduction policies and putting them into effect promptly. But it is also urgent that research and data-gathering programs be strengthened, because what we do *not* know about earthquakes looms as large as what we now know and are neglecting to use. Consequently we need intensified efforts in both research and policy implementation. The Task Force findings and recommendations will help insure that comprehensive seismic safety measures become an integral part of an improved *general* program of disaster prevention and preparedness.

## 2. Disasters Can Happen Anywhere

All portions of the nation can experience major natural disasters of many kinds, but there are also pronounced regional patterns in the geographic distribution of such threats (Figure 1). Every year hurricanes menace the Gulf and Atlantic coasts. Tornadoes occur principally in a circular area ranging from north Texas to Wisconsin. Severe winter storms strike from the Rockies eastward, and primarily north of the nation's midsection.

# FIGURE 1
## Geographic Distribution of Natural Disasters



Earthquakes occur chiefly from the Rockies westward, especially near the Pacific Coast and in Alaska. Alaska, Hawaii and the Pacific Coast are occasionally struck by tsunamis (seismic sea waves). Finally, almost every region of the nation is subject to some form of flooding. Thus, many of our major natural disasters tend to be regional in their areas of severest impact. But disasters can happen anywhere, and every part of the nation is plagued by several varieties.

## 3. Hazard Reduction: A National Concern

Because a major catastrophe of any kind in any locality must be of deep concern to the entire nation, there is a fundamental and abiding moral basis for comprehensive programs of prevention and preparedness. Fortunately, thoughtful and timely precautions can avert many disasters entirely, and can significantly reduce the damaging consequences of others.

### *The Multiple Benefits of Safety Measures*

1. Almost anything that is done in advance to reduce hazards and facilitate recovery from a major disaster is of general value. Thus well-designed preparedness measures and recovery policies can be effective in catastrophic occurrences of many kinds: earthquakes, tsunamis, hurricanes and wind storms, tornadoes, floods, fires and explosions.

2. Further, many of the hazard-reducing measures that prudence and good judgment dictate for earthquakes will also help substantially where hurricanes, tornadoes and winter storms pose the most serious problems. Thus many buildings that will withstand the shaking of an earthquake will also resist the winds of a hurricane or tornado.

3. In seismic regions, proper zoning of shorelines and flood plains can also limit development in many areas that are susceptible to violent, intensified shaking. Moreover, zoning and other regulations that prohibit or restrict building on hazardous slopes will help forestall slide disasters, both during earthquakes and at other times.

4. Much remaining open land in many metropolitan regions is of questionable stability under earthquake conditions: many hillsides, flood plains, marshes, old stream beds and other areas of unconsolidated fill are examples. Thus effective programs for open-space preservation will also help to restrict improper development

where earthquakes would otherwise be likely to cause increased levels of death, injury, and property damage.

### "*Everybody's Business . . .*"

The national scope of major disasters and the multiple benefits of safety measures reinforce the argument that prevention and recovery efforts should receive support from all parts of the nation. But many hazards have been neglected—especially the earthquake menace—because "everybody's business is nobody's business." Moreover, it has proven difficult to focus sustained attention on the need for safety efforts in the case of disasters that occur as infrequently as major earthquakes. These are the principal reasons why the Task Force was created and asked to recommend new research and action programs.

# II.

## A Brief Summary: What Needs To Be Done?

The principal findings and recommendations of the Task Force are grouped logically under seven topic headings in this brief summary, which is based on the discussion in Chapters III and IV.

*1. Priority Programs For Federal Support*—Some priority programs of earthquake-hazard reduction are highly urgent, offer opportunities for substantial early benefits with little cost, and are particularly suitable for Federal encouragement and support.

• These include establishing and enforcing Federal standards requiring earthquake-resistant design and construction of important *publicly owned* facilities, and of *privately owned* facilities built with direct or indirect Federal help. A Federal agency should also enforce adequate standards during the reconstruction period following a major earthquake.

• The Federal government should accelerate work on the mapping of earthquake geologic hazards in metropolitan areas, pursue earthquake insurance studies, vigorously encourage strong-motion earthquake research, and conduct full-scale tests of structures at the Nevada atomic test site.

• The Federal government should help communities evaluate their seismic hazard levels, encourage the states to strengthen their roles in hazard reduction, and take responsibility for a realistic overall plan for earthquake-disaster response.

*2. Some Governmental Tools for Hazard Reduction*—Achieving the goals of all the other programs will depend on effective implementation and enforcement. Thus it will probably be necessary to devise some new governmental machinery for regulation and land use control.

• Financial incentives are needed to encourage high standards of design, and penalties can help discourage poor performance.

• State governments in seismic regions should develop compre-

hensive machinery and policies in the field of earthquake-hazard reduction. California's Joint Committee on Seismic Safety is the only available model for such efforts.

• Federally supported studies measuring earthquake risks posed by different kinds of structures are needed throughout the United States. This research can provide the basis for insurance programs to mitigate the economic impact of earthquake damage.

*3. Urban Planning for Seismic Safety*—Imaginative and prudent planning for urban land use and public facilities can abate existing hazards and reduce those posed by future development. To be effective, good basic planning must be backed by appropriate governmental tools for implementation and enforcement.

*4. Information: Before, During and After Earthquakes*—Special advance provisions should be made for intensive investigation of future earthquakes.

• These efforts should include collection of data on ground movement and other changes before, during and after major events.

• They should also include mapping of faults and significant surface deposits, as well as preparation of earthquake-hazard maps, especially in areas of urban development.

• They should include pre-earthquake investigation of special dangers posed by dams, reservoirs and older buildings. Effective warning systems should be devised as soon as possible, along with improved means for informing the public—especially key public officials—on what to do before, during and after an earthquake.

*5. Strengthening Basic and Applied Research*—Intensified research efforts are needed on earthquake cause, frequency and distribution. Geodetic research is needed to determine more accurately the distortions in the earth's crust that precede, accompany and follow major earthquakes. Research in engineering and design must be augmented substantially in furthering a basic objective: the development of better and safer structures that can withstand foreseeable future shocks.

*6. Coordinating the Federal Agencies*—An effective interdisciplinary advisory group is needed to function in two related areas: (1) problems of Federal organization and administration, and (2) research.

(*1*) *Federal Organization and Administration*—The present multiplicity of agencies poses administrative problems that could be substantially reduced if several of the

competing entities were merged. Meanwhile, pending implementation of an appropriate reorganization, establishment of a knowledgeable interdisciplinary advisory group would appear essential. The advisory group could review the programs and activities of the appropriate Federal agencies, in order to help avoid unjustifiable duplication. To be fully effective, the group should be independent of the Federal agencies concerned.

(*2*) *Research*—The advisory group could help give overall guidance to Federal and other programs of earthquake research. Such guidance would encourage comprehensive and sustained research efforts, and insure that all significant research topics receive the attention they deserve.

*7. Facing Reality: Evaluating the Urgency and Setting Priorities*—A realistic but not hysterical sense of urgency can motivate the setting of priorities for preparedness measures and hazard-reduction efforts.

(*1*) *The Urgency*—A single earthquake could kill large numbers of people, ranging from hundreds to tens of thousands. It could cause property damage ranging from billions to tens of billions of dollars.

(*2*) *Priorities in Safeguarding People and Property*—"What kinds of property must we reconcile ourselves to losing in the next major earthquake?" Answers to this question will help develop priorities, expressed as (a) levels of failure that must be accepted, and (b) unacceptable levels of failure that must be forestalled. The "acceptable" failure level will depend on the nature, use and occupancy of each type of structure or facility.

(*3*) *Priorities for Progress in Seismic Safety*—Comprehensive progress will require an early start and sustained effort *in each of the program categories discussed in Chapter III* under topic heads numbered 1 through 6. Action programs and intensified research efforts must be pursued simultaneously.

Moreover, substantial and sustained progress should be made *in each of the three categories of Task Force recommendations presented in* the Appendix: (1) short-term [A-1 through A-13]; (2) intermediate-term [B-1 through B-7]; and (3) long-term [C-1 through C-8].

# III.

## Principal Findings and Conclusions

### 1. Priority Programs for Federal Support

Several priority programs of earthquake-hazard reduction will yield substantial benefits in return for limited financial outlays. These endeavors are particularly suitable for Federal encouragement and support, both because they are urgently needed and because effective progress demands action at the national level.

*Establishing Federal Standards*

1. All Federal agencies should require proper earthquake-resistant design and construction for all important *publicly owned* facilities that are under their jurisdiction or built with their assistance. [A-1][1]

2. All Federal agencies should consider proper earthquake design and construction for *privately owned* facilities if Federal funds are directly or indirectly involved. [A-2]

3. A single Federal agency should enforce adequate standards for Federal, state and local efforts during the reconstruction period following a major earthquake. Experience demonstrates that, without careful monitoring, standards will be reduced after a disastrous earthquake. Thus strict control is essential to prevent relaxation of standards. It is also highly appropriate because large amounts of public money are used in rebuilding after big earthquakes. Consequently the Federal government has a responsibility for determining that reconstruction funds are not spent on structures and projects that fail to comply with reasonable standards. [A-10]

*Federal Leadership in Information and Research*

Vigorous Federal leadership is essential if comprehensive and balanced earthquake information and research programs are to be

[1] See the Appendix for the text of the Task Force recommendations.

achieved. Thus efforts in basic and applied research should be augmented immediately, and enlarged methodically, in order to insure early and sustained progress on many fronts.[2] Moreover, the Federal government should proceed with several priority projects of an applied nature, including the following:

4. Greatly improved mapping of earthquake geologic hazards in metropolitan regions is essential for adequate evaluation of seismic risk in built up areas. [A-4] More sophisticated risk evaluation is, in turn, the key to well-informed decisions on planning, zoning and code requirements. [A-7]

5. Insurance studies for areas throughout the United States are needed to provide the theoretical equivalent of an actuarial base for insuring property against earthquake damage. These studies should be made in the context of the other natural disaster insurance coverages currently under consideration by the Federal government. [A-11]

6. Appropriate measures should augment greatly the number of installations of strong-motion instruments in various parts of the United States, and pursue vigorously the acquisition of reliable strong-motion data from great earthquakes occurring anywhere in the world. [A-12]

7. Full-scale tests of model structures at the Nevada Test Site of the Atomic Energy Commission should be made in connection with underground nuclear explosions. Laboratory testing of model structures should also be expanded. [A-13]

### *Federal Encouragement of Intergovernmental Efforts*

8. The Federal government should encourage the states to develop their roles in earthquake-hazard reduction. Thus far, California's Joint Committee on Seismic Safety provides the only available model for such activities. [B-5]

9. Appropriate Federal agencies should encourage and assist communities in surveying existing structures and identifying hazards to life and property, in estimating the cost of remedying deficiencies, and in preparing orderly programs of hazard reduction. [A-6]

10. The Federal government should accept responsibility for

[2] See pages 13–14 for further reference to earthquake and seismic information needs, and pages 15–16 for a discussion of basic and applied research needs.

providing a realistic overall plan for earthquake-disaster response. The plan must actively involve state and local governments, voluntary relief agencies such as the Red Cross, and appropriate business and professional groups. [A-9]

## 2. Some Governmental Tools for Hazard Reduction

Governmental tools that can be employed in disaster preparedness and earthquake-hazard reduction include the provision of financial incentives for good performance, and appropriate kinds of tax reform. Zoning and related uses of the police power will also be essential to successful hazard reduction. Finally, earthquake-hazard regulations should be accompanied by new programs of earthquake insurance.

### *Incentives and Tax Reform*

1. In return for complying with high standards of construction or reconstruction, or for achieving timely hazard abatement, property owners could be rewarded by income tax deductions, or other appropriate financial incentives. [B-7]

2. Taxation can be a powerful tool if properly used. At present, however, many aspects of the local revenue system—especially its heavy reliance on the property tax—actually work against the interest of earthquake safety. Thus an owner will be reluctant to make hazard-reducing improvements if they will cause his assessments to increase.

3. Local governments compete with one another for property tax base, and success in this competition means reduced levies on the property taxpayers who live in the winning city. Because it is feared that high standards and strict enforcement may drive away large industrial or commercial tax base increments, local governments find it difficult to adopt and enforce tough policies.

4. Moreover, the need to reestablish the economy promptly—and with it the local tax base—is the principal reason why local governments tend to reduce construction standards during the period of rebuilding after a major earthquake. Yet this is a critical time when high standards are essential to prevent repetition of the same mistakes all over again. [A-10]

5. Some of these pressures can be alleviated by (1) reshaping the tax structure to reduce dependence on local tax sources, and especially on the property tax; (2) providing financial incentives to

local governments for excellence in planning, and for perseverence in maintaining standards; (3) adopting and enforcing regional plans that take the earthquake hazard into account and limit the potential for tax base competition; and (4) providing for a higher level agency to monitor performance and, where necessary, to enforce appropriate standards when local governments do not. [A-10, B-5, B-7]

*Zoning and the Police Power*

6. The zoning of bays, shorelines, flood plains, wetlands and open space has established ample precedent for limiting or prohibiting land development when an important public interest is at stake. These same principles apply in the case of zoning to reduce earthquake hazards, or to prevent their creation by future urban development. In addition to zoning, building code restrictions are, of course, a time-honored exercise of the police power.

7. Inadequacies in seismic safety controls are obviously not caused by a lack of legal *authority*. The real problem lies in these circumstances: (1) the primary power to regulate and enforce is lodged with the cities and counties, many of which have proven vulnerable to developmental pressures; (2) local political "will" is often lacking for the adoption of strong regulations where they are necessary; and (3) local staff capabilities are too limited to insure thorough and uniform enforcement. Consequently we cannot rely solely on local government to provide the policing required for effective earthquake-hazard reduction.

8. The state and Federal governments must take these local handicaps into account and develop better methods of limiting earthquake hazard, perhaps by devising new machinery, or at least by providing for appropriate monitoring of local performance. [A-1, A-2, A-6, A-8, A-10, B-5]

*Insurance*

9. Although earthquake insurance has long been available from private carriers, only a small proportion of the property in high risk areas is actually covered. This situation might be altered by the development of better theoretical studies to establish bases for a more rational structure of insurance offering and premiums. In the event that the national government should assume some role in earthquake insurance, eligibility for protection by Federally aided insurance probably should be contingent on compliance with Federally approved standards of location, design and construction. [A-11]

### 3. Urban Planning for Seismic Safety

All plans and land use controls at every level—Federal, state, regional, and local—should have earthquake-anticipation components suited to prevailing seismic and soil conditions.

1. Urban areas near geologically young or active earthquake faults, and those farther away that are likely to experience significant earthquake shaking, should be zoned for building purposes. Construction in such zones should be subject to regulations by governmental agencies that are capable of administering and enforcing them on a fair and equitable basis. These controls should be designed to minimize future casualties and property damage, so far as is economically feasible. The regulations should be related to the proximity of faults, the likelihood of major earthquakes, estimates of their probable maximum magnitude, soil and water-table conditions, hills and other natural features, population concentrations, and the degree to which known hazards can be minimized by raising design standards. [A-5, B-5]

2. Because large proportions of the funds for regionwide urban planning come from the Federal government, it is essential that the concerned Federal agencies, working with state and local governments, respect known earthquake hazards. Federal assistance should be withheld from any proposed development that does not meet acceptable standards of earthquake safety. [A-1, A-2, A-5]

3. Similarly, as the state governments expand their roles in earthquake-hazard reduction, they will need to include earthquake-anticipation components in all planning for state-supported facilities, and to require appropriate earthquake-anticipation components in the plans of all subsidiary local governments. [B-5]

4. Both the Federal and state governments should consider measures to insure that plans for the construction and operation of privately owned or proprietary facilities whose performance during an earthquake will be crucial—especially power, communications, medical and food distribution facilities—take appropriate account of the possible consequences of an earthquake. [A-2, B-5]

### 4. Information: Before, During and After Earthquakes

1. A study-in-depth should be made of the next major earthquake that occurs in the United States. This work probably should be headed by a Presidential Commission. To facilitate the prompt attention that is essential, special arrangements must be made for

immediately informing engineers, geologists, seismologists and other personnel of the occurrence of a major earthquake, and for insuring their prompt arrival in the affected area. [B-2]

2. Data on ground movement should be obtained before, during and after major earthquakes. [B-2] Special effort must be devoted to the placement of additional strong-motion seismic equipment. This is essential for the collection of information needed to develop improved structural designs for earthquake resistance. Because of their crucial nature, strong-motion data on destructive earthquakes *anywhere in the world* should be obtained, whenever possible. [A-12]

3. Better maps of several kinds are required, including more definitive seismicity or earthquake probability maps; more detailed earthquake geologic hazards maps of metropolitan areas; more informative maps of faults (including displacement histories, especially over the past two million years); and improved maps of deposits at or near the surface. [A-3, A-4, B-3]

4. The earthquake safety of older structures should be reappraised, as should that of both old and new facilities when new hazards are discovered. [A-6, B-6]

5. Automatic warning systems should be installed in connection with dams and other critical facilities. [B-4]

6. The tsunami warning system should be extended and improved. [C-6]

7. The World Wide Network of Standardized Seismographic Stations should be supported on a continuing basis, and expanded where necessary. [C-5]

8. Public officials, the public, and disaster relief agencies such as the Red Cross, should be appropriately and systematically involved in planning how best to prepare for an earthquake. They should be thoroughly briefed on what to expect, as well as on what to do during and after an earthquake. [A-4, A-9] State and local governments need information on the protective and recovery measures that can be taken. [A-8, A-9, A-10, B-5]

9. During and after an earthquake, good communications will be essential among responsible Federal, state, and local officials, and voluntary relief agencies such as the Red Cross. If this goal is to be achieved, a centralized emergency information facility—and a workable emergency information plan—must be in existence before the earthquake occurs. [A-9, B-4]

## 5. Strengthening Basic and Applied Research

### *Providing Balance and Coverage*

1. Earthquake-related research programs need closer attention and more guidance to provide balance and comprehensive coverage, avoid unnecessary duplication, and insure that no important areas are overlooked. Continuing or periodic reviews and evaluations of earthquake research should be made by a team of knowledgeable workers comprising a Federally sponsored advisory group representing the disciplines concerned.[3] It should be their duty to appraise research progress and make appropriate recommendations.

### *Cause, Distribution and Frequency of Earthquakes*

2. Thorough understanding of the nature, cause, distribution and probable frequency of earthquakes is a prerequisite for progress in earthquake safety and earthquake prediction. [C-7] Such information would also help disclose the mechanisms that may trigger earthquakes accidentally, or that perhaps can be employed to set them off intentionally. [C-2, C-3, C-8] In addition, geodetic research is needed to measure more accurately distortions in the earth's crust that precede, accompany and follow major earthquakes. [C-4]

### *Earthquake Engineering for Safer Structures*

3. The basic goal of all earthquake engineering research is the development of better and safer structures, designed to withstand foreseeable future shocks. Because earthquake engineering research is crucial to earthquake-hazard reduction, it should be augmented substantially beyond present levels. [B-1, C-1]

4. There is particular need for engineering research on: (1) interactions between structural and nonstructural components, (2) damping and energy absorption, (3) shock isolation, and (4) the effect of heavy dead loads. Research should also cover the earthquake behavior of special facilities such as dams, towers, long-span structures, shells, domes, and underground or submerged structures. In addition, instrumentation should be developed to yield useful data more quickly during earthquakes and aftershocks. [C-1]

5. Among other matters that should be studied are: (1) design criteria adapted to foundation and subsoil conditions, including various basement rock depths, water-table levels, and liquefaction

[3] See p. 16.

potentials; (2) appropriate criteria for different structural types, uses and hazards; (3) criteria for consistent ultimate safety factors, given different materials and designs; (4) design criteria for nonstructural elements (walls, parapets, glass, and ornamentation); (5) the interaction of soils and foundations; and (6) the strength and capabilities of various components when assembled into a structure. [B-1]

### 6. Coordinating the Federal Agencies

1. Many Federal agencies are now involved in programs of earthquake-related research and hazard reduction. Problems of administrative organization and allocation of responsibilities are numerous, complex, and difficult to deal with. Currently there appear to be no simple solutions that are both administratively sound and politically acceptable. In time, it should be possible to negotiate appropriate agency mergers or responsibility reassignments.

2. Until these organizational problems can be solved, however, creation of an influential advisory group is essential to review agency efforts and research programs, to insure a reasonable degree of coordination and balance, and to reduce or eliminate unjustifiable duplication of effort.

3. The advisory group should be both interdisciplinary and independent of the agencies, although it should include individuals who are well informed on the programs of each agency. The composition of an effective advisory group would probably approximate the membership of the Task Force on Earthquake Hazard Reduction, in terms of disciplines and experience.

4. In addition to helping coordinate agency efforts, the advisory group should be responsible for reviewing and reporting regularly on measures taken to implement Task Force recommendations. Moreover, the advisory group could also attempt to identify areas of insufficient progress, and to suggest methods of achieving the Task Force's objectives.

# IV.

## Facing Reality: Evaluating the Urgency and Setting Priorities

### 1. The Urgency

There are many ways of evaluating the need for accelerated earthquake-hazard reduction and disaster preparedness programs. One good measure of the urgency is found in Richard Jahns' chilling admonition:

> A single earthquake of Richter magnitude eight or more, were it to occur in a metropolitan area under unfavorable circumstances of weather, time of day, and human response, could cause damage of billions to tens of billions of dollars, and the loss of hundreds to tens of thousands of lives.

### 2. Priorities in Safeguarding People and Property

Some generalized but useful priorities can be based on answers to the question: "What kinds of property must we reconcile ourselves to losing in the next major earthquake?" (1) Perhaps we must accept heavy damage of some apartment houses and high-rise office buildings, provided they do not fail totally and catastrophically, thereby causing injury and death. (2) Presumably much lower levels of failure would be tolerable in the case of dams, public utilities, and other facilities whose damage or loss would cause extensive casualties or severe hardship affecting large populations. (3) Very little failure seems acceptable in the case of medical, health and fire protection facilities, whose functioning will be crucial for handling casualties and holocaust in the aftermath of a major earthquake. (4) Certain kinds of hazardous construction—especially poorly reinforced parapets—are very dangerous and relatively easy to remedy. There is little excuse for retaining them.

The inventory of existing structures and facilities, which pose the greatest risk to life and property, must be treated differently

from the relatively small annual increment of new buildings. Astronomical costs prohibit early removal of all earthquake hazards in existing structures, although the worst can be condemned, and others strengthened. Parapet safety programs can also help a great deal. For the most part, however, replacement of structures will occur gradually through superannuation, redevelopment, or destruction by disasters such as earthquakes.

On the other hand, improved design of new buildings reduces their risk levels from the start. Moreover, in due time steady increments of good new construction will bring substantial improvements in the overall seismic safety of our urban physical plant. Thus it is essential that earthquake engineering research address itself both to existing structures and to new design.

Both technical knowledge and common sense must underlie priority judgements needed to guide future disaster preparedness and earthquake-hazard reduction. Federally supported basic and applied research will be required to provide the detailed information necessary. The priorities can then be formulated into an orderly hazard-reduction program by state-sponsored and Federally supported efforts like California's Joint Committee on Seismic Safety. [A-7, B-5]

### 3. Priorities for Progress in Seismic Safety

Comprehensive progress in preparedness and hazard reduction will require simultaneous action on many fronts. *An early start should be made—and a high level of accomplishment sought—in each of the program categories presented in Chapter III under numbered subheads 1 through 6.* Action programs should not be favored to the disadvantage of research, nor should Federal programs be emphasized to the exclusion of state and local accomplishment. All must be pursued at once.

Moreover, *substantial and sustained progress should be made in each of the three categories of Task Force recommendations presented in the Appendix:* short-term [A-1 through A-13], intermediate-term [B-1 through B-7], and long-term [C-1 through C-8].

The advisory group whose establishment was recommended in Chapter III, page 16, should report regularly on earthquake research and on accomplishments in disaster preparedness and hazard reduction. By reviewing the orderly achievement of Task Force objectives, the advisory group can help insure comprehensive and sustained forward movement.

## APPENDIX

# Recommendations of the Task Force[1]

### A. THE FOLLOWING MEASURES WILL PROBABLY BEGIN TO YIELD SIGNIFICANT BENEFITS IN A COMPARATIVELY SHORT TERM OF LESS THAN FIVE YEARS

A-1 All Federal agencies should require proper earthquake resistant design and construction for all important publicly owned facilities under their jurisdiction or built with their assistance.

A-2 All Federal agencies should consider proper earthquake design and construction for privately owned facilities whenever Federal funds are directly or indirectly involved.

A-3 Improved seismicity maps should be developed.

A-4 Much more complete earthquake geologic hazards maps for the metropolitan areas of the United States should be prepared and provisions made for their regular updating and use.

A-5 The concerned Federal agencies, working with state and local agencies, should respect known earthquake hazards in their urban planning and development decision making.

A-6 To begin to minimize the collapse hazard of the older non-earthquake resistant structures in the highest earthquake hazard zones, the appropriate Federal agencies should en-

[1] For further discussion of the recommendations, see: U. S. Executive Office of the President, Office of Science and Technology, *Earthquake Hazard Reduction* (Washington, D.C., August 1970).

courage as well as aid communities to survey existing structures to identify the risk in terms of lives, property and cost required to remedy these deficient structures, and to develop orderly programs for hazard reduction.

A-7 Realistic cost-benefit studies in terms of earthquake risk should be made on an interdisciplinary as well as interagency basis.

A-8 The dissemination and implementation of earthquake geologic hazards information for use by state and local governments should be coordinated by the state government when the state has or develops this capability.

A-9 It is a Federal responsibility to provide a realistic total plan for earthquake disaster response, and the plan must actively involve state and local governments where the hazard warrants.

A-10 A single Federal agency should tightly coordinate and maintain good standards for the Federal, state, and local effort during the reconstruction period following an earthquake to prevent the relaxation of standards that has happened in the past.

A-11 Accelerated insurance oriented studies for areas throughout the United States are required in order to develop the theoretic equivalents of the actuarial bases needed for earthquake property insurance. Additionally, these studies should be made in the context of the other natural disaster insurance coverages currently under consideration by the Federal government.

A-12 Greatly increased effort must be devoted to the intelligent placement of strong motion seismic equipment, the collection of their records after destructive earthquakes, analyzing the motion to derive various engineering characteristics and making the original data and analyses available shortly after the earthquake.

A-13 Full scale dynamic testing of members, connections and structural systems, including factory produced housing, is necessary.

## B. THE FOLLOWING MEASURES WILL PROBABLY BEGIN TO YIELD SIGNIFICANT BENEFITS DURING AN INTERMEDIATE TERM OF FIVE TO TEN YEARS

B-1 Applied research on earthquake engineering should be greatly augmented and re-directed to obtain the most needed and most beneficial results in the development of design criteria.

B-2 Post-earthquake studies in all relevant disciplines should be conducted immediately after any major earthquake, and the resulting data should quickly be analyzed and disseminated.

B-3 Research is needed on faults and fault displacements as well as certain types of geologic mapping.

B-4 Within areas of high seismicity, such as California and Nevada, efforts should be made to expand and coordinate telemetered seismographic networks, so that immediate information on the locations and magnitudes of potentially destructive earthquakes is promptly available to all interested agencies. For the entire United States, the existing networks should be expanded to assure more adequate data on seismicity.

B-5 With Federal cooperation and support, the states most seriously exposed to earthquake hazard should reexamine and develop their roles in reducing this hazard.

B-6 If new information discloses that a certain type of construction or built-upon area—previously thought to be safe—is seriously hazardous, it should be Federal policy for all agencies to take corrective measures, or the building or area should be evacuated.

B-7 The present Federal and local tax structures, both for property and income taxes, should be revised to provide incentives and/or penalties which will aid earthquake hazard reduction programs.

## C. THE FOLLOWING MEASURES WILL PROBABLY BEGIN TO YIELD SIGNIFICANT LONG-TERM BENEFITS AFTER 10 YEARS OR MORE

C-1 Basic research in earthquake engineering is needed on a wide variety of subjects, and many of these must be more clearly related to problem areas in applied earthquake engineering than they have been in the past.

C-2 Those Federal agencies and organizations engaged in or supporting research in seismology should encourage research relevant to the problems of prediction. Attention should be paid to all aspects of the problem—social and economic consequences of success or partial success as well as the statistical, geological, and physical theory.

C-3 Those Federal agencies and organizations conducting or supporting research and observation in seismology should be encouraged to pay particular attention to the problems relating to the advertent or inadvertent triggering of earthquakes.

C-4 An expanded program of geodetic measurements is needed in order to delineate more adequately the distortions of the earth's crust that precede, accompany, and follow major earthquakes.

C-5 The World Wide Network of Standardized Seismographic Stations (WWSSN) should be supported on a continuing basis as an integral part of the earthquake hazards reduction program.

C-6 The concerned Federal agency should continue to improve the reliability of the tsunami (seismic sea wave) warning system.

C-7 Basic research in seismology is essential to our understanding and solution of the entire earthquake hazard problem. A strong program of basic research must be supported.

C-8 Basic research on causes and mechanisms of crustal failure should be vigorously encouraged and supported.